

APPENDIX BMP-14a

Design Procedure for Temporary Sediment Basins

The following design procedure provides a step-by-step method for the design of a temporary sediment basin. The data sheet found in the back of this Appendix should be used in the erosion and sediment control plan to outline design values calculated.

I. Basin Volume

- A. Determine the required basin volume. The design capacity of the basin must be at least 254 cubic meters per hectare (134 cubic yards per acre) of total contributing drainage area, half of which shall be in the form of a permanent pool or wet storage, and the remaining half as a "drawdown" area or dry storage.
 1. For a natural basin, the wet storage volume may be approximated as follows:

$$V_1 = 0.4 \times A_1 \times D_1$$

where,

V_1 = the wet storage volume in cubic meters (cubic feet)

A_1 = the surface area of the flooded area at the invert of the dewatering outlet, in square meters (square feet)

D_1 = the maximum depth in meters (feet), measured from the low point in the basin to the invert of the dewatering outlet

2. For a natural basin, the dry storage volume may be approximated as follows:

$$V_2 = (A_1 + A_2) / 2 \times D_2$$

where,

V_2 = the dry storage volume in cubic meters (cubic feet)

- A_1 = the surface area of the flooded area at the invert of the dewatering outlet, in square meters (square feet) - see #1 above
 A_2 = the surface area of the flooded area at the crest of the principal spillway
 D_2 = the depth, in meters (feet), measured from the invert of the dewatering outlet to the crest of the principal spillway

Note 1: The volumes may be computed from more precise contour information or other suitable methods.

Note 2: Conversion between acres to hectares and cubic meters to cubic feet and cubic yards is as follows:

$$\begin{aligned}
 \text{acres} &= \text{number of hectares} \times 2.47 \\
 \text{cubic feet} &= \text{number of cubic meters} \times 35.31 \\
 \text{number of cubic yards} &= \text{number of cubic meters} \times 1.308
 \end{aligned}$$

- B. If the volume of the basin is inadequate or embankment height becomes excessive, pursue the use of excavation to obtain the required volume.

II. Basin Shape

- A. The shape of the basin must be such that the length-to-width ratio is at least 2 to 1 according to the following equation:

$$\text{Length-to-width Ratio} = L / W_e$$

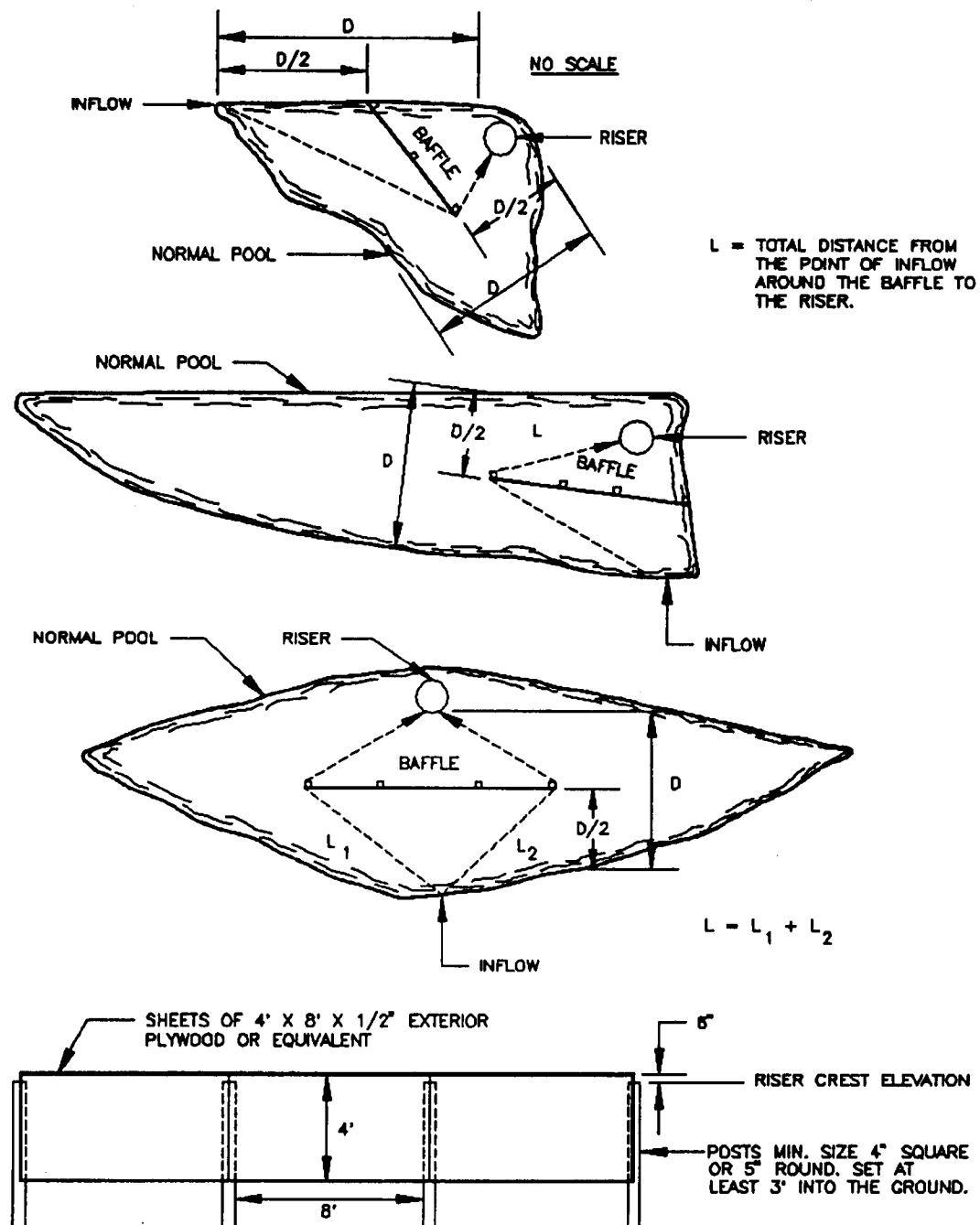
where,

- W_e = A/L = the effective width
 A = the surface area of the normal pool
 L = the length of the flow path from the inflow to the outflow. If there is more than one inflow point, any inflow which carries more than 30% of the peak rate of inflow must meet these criteria.

- B. The correct basin shape can be obtained by proper site selection, excavation, or the use of baffles. Baffles increase the flow length by deflecting the flow. The baffles should be placed halfway between the inflow point and the outflow. Figure 14-1 shows the detail for baffle construction and three situations where baffles might be used.
- III. Determine whether the basin will have a separate emergency spillway.
- IV. Determine the elevation of the crest of the principal spillway for the required volume - dewatering orifice at 127 cubic meters per hectare (67 cubic yards per acre) and crest of principal spillway - 254 cubic meters per hectare (134 cubic yards per acre).
- V. Estimate the elevation of the design high water and the required height of the dam.
- A. If an emergency spillway is included, the crest of the principal spillway must be at least 300 millimeters (1.0 foot) below the crest of the emergency spillway.
- B. If an emergency spillway is included, the elevation of the peak flow through the emergency spillway (which will be the design high water for the 25-year storm) must be at least 300 millimeters below the top of embankment.
- C. If an emergency spillway is not included, the crest of the principal spillway must be at least 1 meter (3 feet) below the top of the embankment.
- D. If an emergency spillway is not included, the elevation of the design high water for the 25-year storm must be 600 millimeters (2.0 feet) below the top of the embankment.
- VI. Principal Spillway Design
- A. If an emergency spillway is included, the principal spillway must at least pass the peak rate of runoff from the basin drainage area for a 2-year storm. Therefore,

$$Q_p = \text{the 2-year peak rate of runoff.}$$

FIGURE 14-1: EXAMPLE PLAN VIEWS OF BAFFLE LOCATIONS IN SEDIMENT BASINS



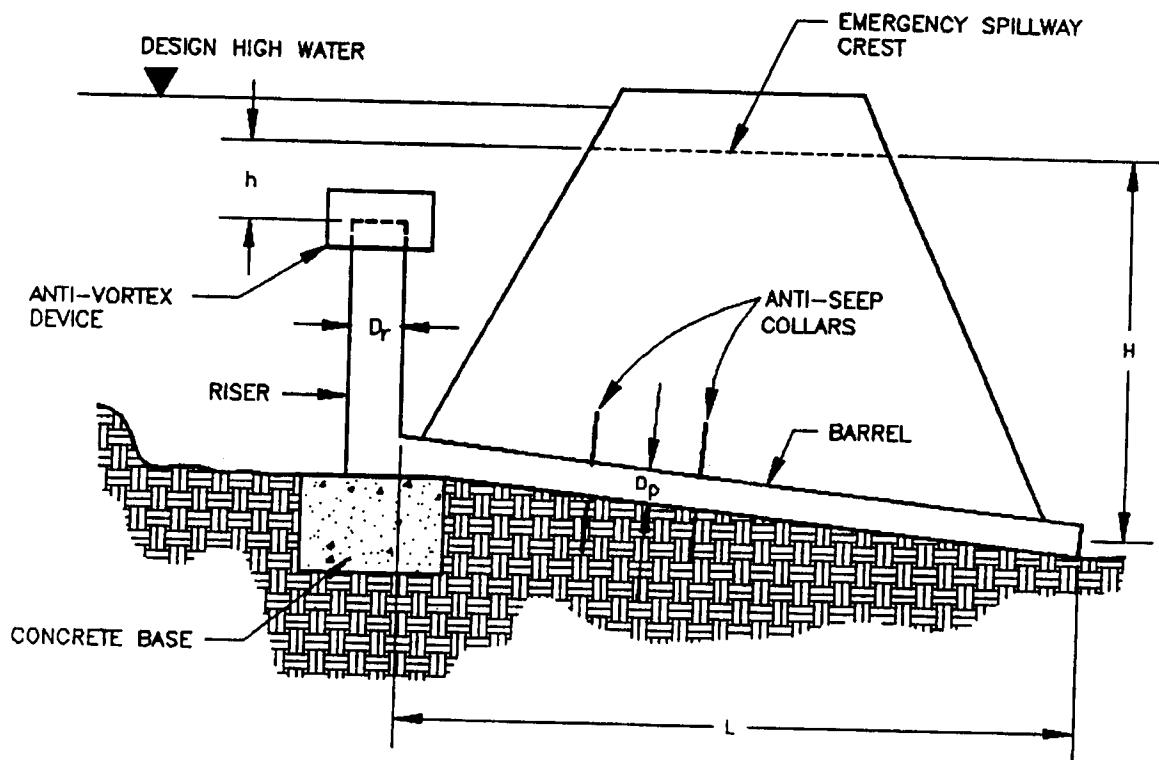
- B. If an emergency spillway is not included, the principal spillway must pass the peak rate of runoff from the basin drainage area for a 25-year storm. Therefore,

$$Q_p = \text{the 25-year peak rate of runoff.}$$
- C. Refer to Figure 14-2, where h is the difference between the elevation of the crest of the principal spillway and the elevation of the crest of the emergency spillway.
- D. Enter Figure 14-3 with Q_p . Choose the smallest riser which will pass the required flow with the available head, h .
- E. Refer to Figure 14-2, where H is the difference in elevation of the centerline of the outlet of the barrel and the crest of the emergency spillway. L is the length of the barrel through the embankment.
- F. Enter Table 14-1 or Table 14-2 with H . Choose the smallest size barrel which will pass the flow provided by the riser. If L is other than 21 meters (70 feet), make the necessary correction.

VII. Emergency Spillway Design

- A. The emergency spillway must pass the remainder of the 25-year peak rate of runoff not carried by the principal spillway.
- B. Compute, $Q_e = Q_{25} - Q_p$
- C. Refer to Table 14-3 and Figure 14-4.
- D. Determine approximate permissible values for b , the bottom width; s , the slope of the exit channel; and x , minimum length of the exit channel.
- E. Enter Table 14-3 and choose an exit channel cross-section which passes the required flow and meets the other constraints of the site.
- F. Note:
 1. The maximum permissible velocity for vegetated waterways must be considered when designing an exit channel.
 2. For a given H_p , a decrease in the exit slope from S as given in the table decreases spillway discharge, but increasing the exit

FIGURE 14-2: PRINCIPAL SPILLWAY DESIGN



H = HEAD ON PIPE THROUGH EMBANKMENT

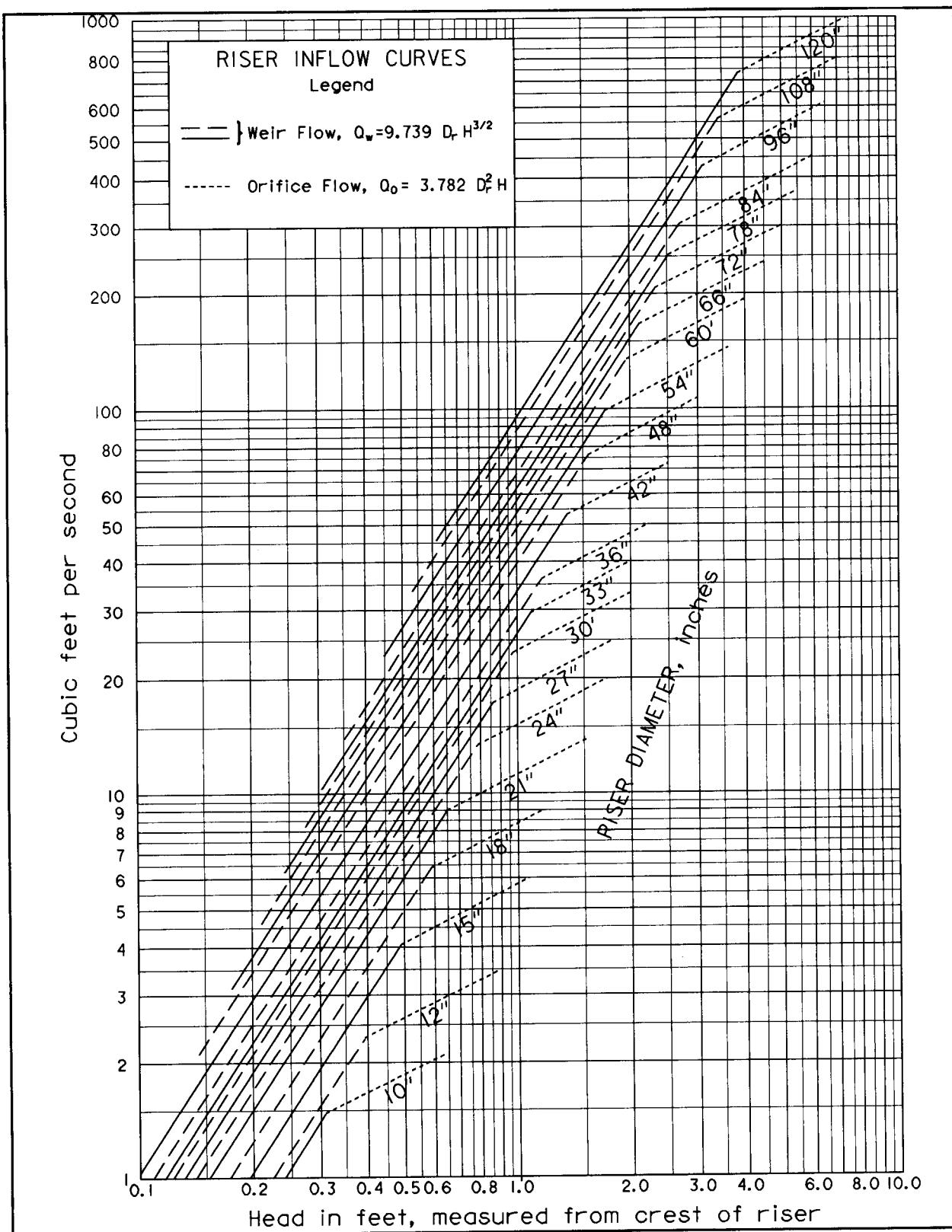
h = HEAD OVER RISER CREST

L = LENGTH OF PIPE THROUGH EMBANKMENT

D_p = DIAMETER OF PIPE THROUGH EMBANKMENT

D_r = DIAMETER OF RISER

FIGURE 14-3



SOURCE: USDA-SCS

METRIC CONVERSIONS:

CUBIC METERS PER SECOND = CUBIC FEET PER SECOND $\times 0.0283$
MILLIMETERS = INCHES $\times 25.4$

TABLE 14-1: PIPE FLOW CHART, $n = 0.025$

FOR CORRUGATED METAL PIPE INLET $K_m = K_e + K_b = 1.0$ AND 70 FEET OF CORRUGATED METAL PIPE CONDUIT (full flow assumed)

Note correction factors for pipe lengths other than 70 feet
diameter of pipe in inches

H, in feet	6"	8"	10"	12"	15"	18"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"	102"
1	0.33	0.70	1.25	1.96	3.48	5.47	7.99	11.0	18.6	28.8	41.1	55.7	72.6	91.8	113	137	163	191	222	255	290
2	0.47	0.99	1.76	2.80	4.92	7.74	11.3	15.6	26.6	40.8	58.2	78.8	103	130	160	194	231	271	314	360	410
3	0.58	1.22	2.16	3.43	6.02	9.48	13.8	19.1	32.6	49.9	71.2	96.5	126	159	196	237	282	331	384	441	502
4	0.67	1.40	2.49	3.97	6.96	10.9	16.0	22.1	37.6	57.7	82.3	111	145	184	226	274	326	383	444	510	580
5	0.74	1.57	2.79	4.43	7.78	12.2	17.9	24.7	42.1	64.5	92.0	125	162	205	253	306	365	428	496	570	648
6	0.82	1.72	3.05	4.86	8.52	13.4	19.6	27.0	46.1	70.6	101	136	178	225	277	336	399	469	544	624	710
7	0.88	1.86	3.30	5.25	9.20	14.5	21.1	29.2	49.8	76.3	109	147	192	243	300	362	431	506	587	674	767
8	0.94	1.99	3.53	5.61	9.84	15.5	22.6	31.2	53.2	81.5	116	158	205	260	320	388	461	541	628	721	820
9	1.00	2.11	3.74	5.95	10.4	16.4	24.0	33.1	56.4	86.5	123	167	218	275	340	411	489	574	666	764	870
10	1.05	2.22	3.94	6.27	11.0	17.3	25.3	34.9	59.5	91.2	130	176	230	290	358	433	516	605	702	806	917
11	1.10	2.33	4.13	6.58	11.5	18.2	26.5	36.6	62.4	95.6	136	185	241	304	376	454	541	635	736	845	962
12	1.15	2.43	4.32	6.87	12.1	19.0	27.7	38.2	65.2	99.9	142	193	252	318	392	475	565	663	769	883	1004
13	1.20	2.53	4.49	7.15	12.6	19.7	28.8	39.8	67.8	104	148	201	262	331	408	494	588	690	800	919	1045
14	1.25	2.63	4.66	7.42	13.0	20.5	29.9	41.3	70.4	108	154	208	272	343	424	513	610	716	830	953	1085
15	1.29	2.72	4.83	7.68	13.5	21.2	30.9	42.8	72.8	112	159	216	281	355	439	531	631	741	860	987	1123
16	1.33	2.81	4.99	7.93	13.9	21.9	32.0	44.2	75.2	115	165	223	290	367	453	548	652	765	888	1019	1160
17	1.37	2.90	5.14	8.18	14.3	22.6	32.9	45.5	77.5	119	170	230	299	378	467	565	672	789	915	1051	1195
18	1.41	2.98	5.29	8.41	14.8	23.2	33.9	46.8	79.8	120	174	236	308	389	480	581	692	812	942	1081	1230
19	1.45	3.06	5.43	8.64	15.2	23.9	34.8	48.1	82.0	126	179	243	316	400	494	597	711	834	967	1111	1264
20	1.49	3.14	5.57	8.87	15.6	24.5	35.7	49.4	84.1	129	184	249	325	410	506	613	729	856	993	1139	1297
21	1.53	3.22	5.71	9.09	15.9	25.1	36.6	50.6	86.2	132	188	255	333	421	519	628	747	877	1017	1168	1329
22	1.56	3.29	5.85	9.30	16.3	25.7	37.5	51.8	88.2	135	193	261	341	430	531	643	765	898	1041	1195	1360
23	1.60	3.37	5.98	9.51	16.7	26.2	38.3	53.0	90.2	138	197	267	348	440	543	657	782	918	1064	1222	1390
24	1.63	3.44	6.11	9.72	17.0	26.8	39.1	54.1	92.1	141	201	273	356	450	555	671	799	937	1087	1248	1420
25	1.66	3.51	6.23	9.92	17.4	27.4	39.9	55.2	94.0	144	206	279	363	459	566	685	815	957	1110	1274	1450
26	1.70	3.58	6.36	10.1	17.7	27.9	40.7	56.3	95.9	147	210	284	370	468	577	699	831	976	1132	1299	1478
27	1.73	3.65	6.48	10.3	18.1	28.4	41.5	57.4	97.7	150	214	290	377	477	588	712	847	994	1153	1324	1507
28	1.76	3.72	6.60	10.5	18.4	29.0	42.3	58.4	99.5	153	218	295	384	486	599	725	863	1013	1174	1348	1534
29	1.79	3.78	6.71	10.7	18.7	29.5	43.0	59.5	101	155	221	300	391	494	610	738	878	1030	1195	1372	1561
30	1.82	3.85	6.83	10.9	19.1	30.0	43.7	60.5	103	158	225	305	398	503	620	750	893	1048	1216	1396	1588

L, in feet	Correction Factors For Other Pipe Lengths																					
20	1.69	1.63	1.58	1.53	1.47	1.42	1.37	1.34	1.28	1.24	1.20	1.18	1.16	1.14	1.13	1.11	1.10	1.10	1.09	1.08	1.08	
30	1.44	1.41	1.39	1.36	1.32	1.29	1.27	1.24	1.21	1.18	1.15	1.13	1.12	1.11	1.10	1.09	1.08	1.07	1.07	1.06	1.06	
40	1.28	1.27	1.25	1.23	1.21	1.20	1.18	1.17	1.14	1.12	1.11	1.10	1.09	1.08	1.07	1.06	1.06	1.05	1.05	1.05	1.04	
50	1.16	1.16	1.15	1.14	1.13	1.12	1.11	1.10	1.09	1.08	1.07	1.06	1.06	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	
60	1.07	1.07	1.07	1.06	1.06	1.05	1.05	1.04	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.01	
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
80	.94	.94	.95	.95	.95	.95	.96	.96	.96	.97	.97	.97	.98	.98	.98	.98	.98	.98	.98	.99	.99	.99
90	.89	.89	.90	.90	.91	.91	.92	.92	.93	.94	.94	.95	.95	.96	.96	.96	.96	.97	.97	.97	.97	.94
100	.85	.85	.86	.86	.87	.88	.89	.89	.90	.91	.92	.93	.93	.94	.94	.94	.95	.95	.95	.96	.96	.94
120	.78	.79	.79	.80	.81	.82	.83	.83	.85	.86	.87	.88	.89	.90	.91	.91	.92	.93	.93	.94	.92	.92
140	.72	.73	.74	.75	.76	.77	.78	.79	.81	.82	.84	.85	.86	.87	.88	.86	.89	.90	.91	.91	.90	.90
160	.68	.69	.69	.70	.71	.73	.74	.75	.77	.79	.80	.82	.83	.84	.85	.92	.87	.88	.89	.89	.88	.89

Typical Metric Conversions:

Meters = 0.3048 x feet

millimeters = 25.4 x inches

TABLE 14-2: PIPE FLOW CHART, $n = 0.013$

FOR REINFORCED CONCRETE PIPE INLET $K_a = K_g + K_b = 0.65$ AND 70 FEET OF REINFORCED CONCRETE PIPE CONDUIT (full flow assumed)
Note correction factors for pipe lengths other than 70 feet
diameter of pipe in inches

H, in feet	12"	15"	18"	21"	24"	30"	36"	42"	48"	54"	60"	66"	72"	78"	84"	90"	96"	102"
1	3.22	5.44	8.29	11.8	15.9	26.0	38.6	53.8	71.4	91.5	114	139	167	197	229	264	302	342
2	4.55	7.69	11.7	16.7	22.5	36.8	54.6	76.0	101	129	161	197	236	278	324	374	427	483
3	5.57	9.42	14.4	20.4	27.5	45.0	66.9	93.1	124	159	198	241	289	341	397	458	523	592
4	6.43	10.9	16.6	23.5	31.8	52.0	77.3	108	143	183	228	278	334	394	459	529	604	683
5	7.19	12.2	18.5	26.3	35.5	58.1	86.4	120	160	205	255	311	373	440	513	591	675	764
6	7.88	13.3	20.3	28.8	38.9	63.7	94.6	132	175	224	280	341	409	482	542	647	739	837
7	8.51	14.4	21.9	31.1	42.0	68.8	102	142	189	242	302	368	441	521	607	699	798	904
8	9.10	15.4	23.5	33.3	44.9	73.5	109	152	202	259	323	394	472	557	685	748	854	966
9	9.65	16.3	24.9	35.3	47.7	78.0	116	161	214	275	342	418	500	590	688	793	905	1025
10	10.2	17.2	26.2	37.2	50.2	82.2	122	170	226	289	361	440	527	622	725	836	954	1080
11	10.7	18.0	27.5	39.0	52.7	86.2	128	178	237	304	379	462	553	653	761	877	1001	1133
12	11.1	18.9	28.7	40.8	55.0	90.1	134	186	247	317	395	482	578	682	794	916	1045	1184
13	11.6	19.6	29.9	42.4	57.3	93.7	139	194	257	330	411	502	601	710	827	953	1088	1232
14	12.0	20.4	31.0	44.1	59.4	97.3	145	201	267	342	427	521	624	736	858	989	1129	1278
15	12.5	21.1	32.1	45.6	61.5	101	150	208	277	354	442	539	646	762	888	1024	1169	1323
16	12.9	21.8	33.2	47.1	63.5	104	155	215	286	366	457	557	667	787	917	1057	1207	1367
17	13.3	22.4	34.2	48.5	65.5	107	159	222	294	377	471	574	688	812	946	1090	1244	1409
18	13.7	23.1	35.2	49.9	67.4	110	164	228	303	388	484	591	708	835	973	1121	1280	1450
19	14.0	23.7	36.1	51.3	69.2	113	168	234	311	399	497	607	727	858	1000	1152	1315	1489
20	14.4	24.3	37.1	52.6	71.0	116	173	240	319	409	510	623	746	880	1026	1182	1350	1528
21	14.7	24.9	38.0	53.9	72.8	119	177	246	327	419	523	638	764	902	1051	1211	1383	1566
22	15.1	25.5	38.9	55.2	74.5	122	181	252	335	429	535	653	782	923	1076	1240	1415	1603
23	15.4	26.1	39.8	56.5	76.2	125	186	258	342	439	547	668	800	944	1100	1268	1447	1639
24	15.8	26.7	40.6	57.7	77.8	127	189	263	350	448	559	682	817	964	1123	1295	1478	1674
25	16.1	27.2	41.5	58.9	79.4	130	193	269	357	458	571	696	834	984	1147	1322	1509	1708
26	16.4	27.7	42.3	60.0	81.0	133	197	274	364	467	582	710	850	1004	1169	1348	1539	1742
27	16.7	28.3	43.1	61.2	82.5	135	201	279	371	476	593	723	867	1023	1192	1373	1568	1775
28	17.0	28.8	43.9	62.3	84.1	138	204	285	378	484	604	737	883	1041	1214	1399	1597	1808
29	17.3	29.3	44.7	63.4	85.5	140	208	290	384	493	615	750	898	1060	1235	1423	1625	1840
30	17.6	29.8	45.4	64.5	87.0	142	212	294	391	501	625	763	913	1078	1256	1448	1653	1871
L, in feet	Correction Factors For Other Pipe Lengths																	
20	1.30	1.24	1.21	1.18	1.15	1.12	1.10	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.03	1.03	1.03
30	1.22	1.18	1.15	1.13	1.12	1.09	1.08	1.06	1.05	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.02
40	1.15	1.13	1.11	1.10	1.08	1.07	1.05	1.05	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.02	1.02	1.02
50	1.09	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01
60	1.04	1.04	1.03	1.03	1.03	1.02	1.02	1.02	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01	1.01
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	.96	.97	.97	.97	.98	.98	.98	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99	.99
90	.93	.94	.94	.95	.95	.96	.97	.97	.98	.98	.98	.98	.98	.99	.99	.99	.99	.99
100	.90	.91	.92	.93	.93	.95	.95	.96	.97	.97	.98	.98	.98	.98	.98	.98	.98	.98
120	.84	.86	.87	.89	.90	.91	.93	.94	.94	.95	.96	.96	.97	.97	.97	.97	.97	.98
140	.80	.82	.83	.85	.86	.88	.90	.91	.92	.93	.94	.94	.95	.95	.96	.96	.96	.97
160	.76	.78	.80	.82	.83	.86	.88	.89	.90	.91	.92	.93	.94	.94	.95	.95	.95	.96

Typical Metric Conversions:

Meters = 0.3048 x feet

millimeters = 25.4 x inches

TABLE 14-3: DESIGN DATA FOR SPILLWAYS¹

Stage (H _p) (feet)	Spillway Variables	Bottom Width (b) in Feet																	
		8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	
0.5	Q	6	7	8	10	11	13	14	15	17	18	20	21	22	24	25	27	28	
	V	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	
	S	3.9	3.9	3.9	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
	X	32	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	33	
0.6	Q	8	10	12	14	16	18	20	22	24	26	28	30	32	34	35	37	39	
	V	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
	S	3.7	3.7	3.7	3.7	3.6	3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	
	X	36	36	36	36	36	36	37	37	37	37	37	37	37	37	37	37	37	
0.7	Q	11	13	16	18	20	23	25	28	30	33	35	38	41	43	44	46	48	
	V	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	
	S	3.5	3.5	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	
	X	39	40	40	40	41	41	41	41	41	41	41	41	41	41	41	41	41	
0.8	Q	13	16	19	22	26	29	32	35	38	42	45	46	48	51	54	57	60	
	V	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	
	S	3.3	3.3	3.3	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	
	X	44	44	44	44	45	45	45	45	45	45	45	45	45	45	45	45	45	
0.9	Q	17	20	24	28	32	35	39	43	47	51	53	57	60	64	68	71	75	
	V	3.7	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	
	S	3.2	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	
	X	47	47	48	48	48	48	48	48	48	48	49	49	49	49	49	49	49	
1.0	Q	20	24	29	33	38	42	47	51	56	61	63	68	72	77	81	86	90	
	V	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	
	S	3.1	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
	X	51	51	51	51	52	52	52	52	52	52	52	52	52	52	52	52	52	
1.1	Q	23	28	34	39	44	49	54	60	65	70	74	79	84	89	95	100	105	
	V	4.2	4.2	4.2	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	4.3	
	S	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	
	X	55	55	55	55	55	55	55	56	56	56	56	56	56	56	56	56	56	
1.2	Q	28	33	40	45	51	58	64	69	76	80	86	92	98	104	110	116	122	
	V	4.4	4.4	4.4	4.4	4.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
	S	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	
	X	58	58	59	59	59	59	59	59	60	60	60	60	60	60	60	60	60	
1.3	Q	32	38	46	53	58	65	73	80	86	91	99	106	112	119	125	133	140	
	V	4.5	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	
	S	2.8	2.8	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	
	X	62	62	62	63	63	63	63	63	63	63	64	64	64	64	64	64	64	
1.4	Q	37	44	51	59	66	74	82	90	96	103	111	119	127	134	142	150	158	
	V	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.9	4.9	4.9	4.9	4.9	4.9	4.9	4.9	
	S	2.8	2.7	2.7	2.7	2.7	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	
	X	65	66	66	66	66	67	67	67	67	67	68	68	68	68	68	68	69	

TABLE 14-3: DESIGN DATA FOR SPILLWAYS Continued

Stage (H _p) (feet)	Spillway Variables	Bottom Width (b) in Feet																
		8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
1.5	Q	41	50	58	66	75	85	92	101	108	116	125	133	142	150	160	169	175
	V	4.8	4.9	4.9	5	5	5	5	5	5	5	5	5	5	5	5.1	5.1	5.1
	S	2.7	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5
	X	69	69	70	70	71	71	71	71	71	71	71	72	72	72	72	72	72
1.6	Q	46	56	65	75	84	94	104	112	122	132	142	149	158	168	178	187	197
	V	5.0	5.1	5.1	5.1	5.1	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2	5.2
	S	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	X	72	74	74	75	75	76	76	76	76	76	76	76	76	76	76	76	76
1.7	Q	52	62	72	83	94	105	115	126	135	145	156	167	175	187	196	206	217
	V	5.2	5.2	5.2	5.3	5.3	5.3	5.3	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
	S	2.6	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	X	76	78	79	80	80	80	80	80	80	80	80	80	80	80	80	80	80
1.8	Q	58	69	81	93	104	116	127	138	150	160	171	182	194	204	214	226	233
	V	5.3	5.4	5.4	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.6	5.6	5.6	5.6	5.6	5.6
	S	2.5	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	X	80	82	83	84	84	84	84	84	84	84	84	84	84	84	84	84	84
1.9	Q	64	76	88	102	114	127	140	152	164	175	188	201	213	225	235	248	260
	V	5.5	5.5	5.5	5.6	5.6	5.6	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
	S	2.5	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	X	84	85	86	87	88	88	88	88	88	88	88	88	88	88	88	88	88
2.0	Q	71	83	97	111	125	138	153	164	178	193	204	218	232	245	256	269	283
	V	5.6	5.7	5.7	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.9	5.9	5.9	5.9	5.9	5.9
	S	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	X	88	90	91	91	91	91	92	92	92	92	92	92	92	92	92	92	92
2.1	Q	77	91	107	122	135	149	162	177	192	207	220	234	250	267	276	291	305
	V	5.7	5.8	5.9	5.9	5.9	5.9	5.9	6	6	6	6	6	6	6	6	6	6
	S	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
	X	92	93	95	95	95	95	95	95	95	96	96	96	96	96	96	96	96
2.2	Q	84	100	116	131	146	163	177	194	210	224	238	253	269	288	301	314	330
	V	5.9	5.9	6.0	6.0	6.0	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.2	6.2	6.2	6.2
	S	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
	X	96	98	99	99	99	99	99	100	100	100	100	100	100	100	100	100	100
2.3	Q	90	108	124	140	158	175	193	208	226	243	258	275	292	306	323	341	354
	V	6.0	6.1	6.1	6.1	6.2	6.2	6.2	6.2	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
	S	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
	X	100	102	102	103	103	103	104	104	104	105	105	105	105	105	105	105	105
2.4	Q	99	116	136	152	170	189	206	224	241	260	275	294	312	327	346	364	378
	V	6.1	6.2	6.2	6.3	6.3	6.3	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
	S	2.3	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
	X	105	105	106	107	107	108	108	108	108	109	109	109	109	109	109	109	109

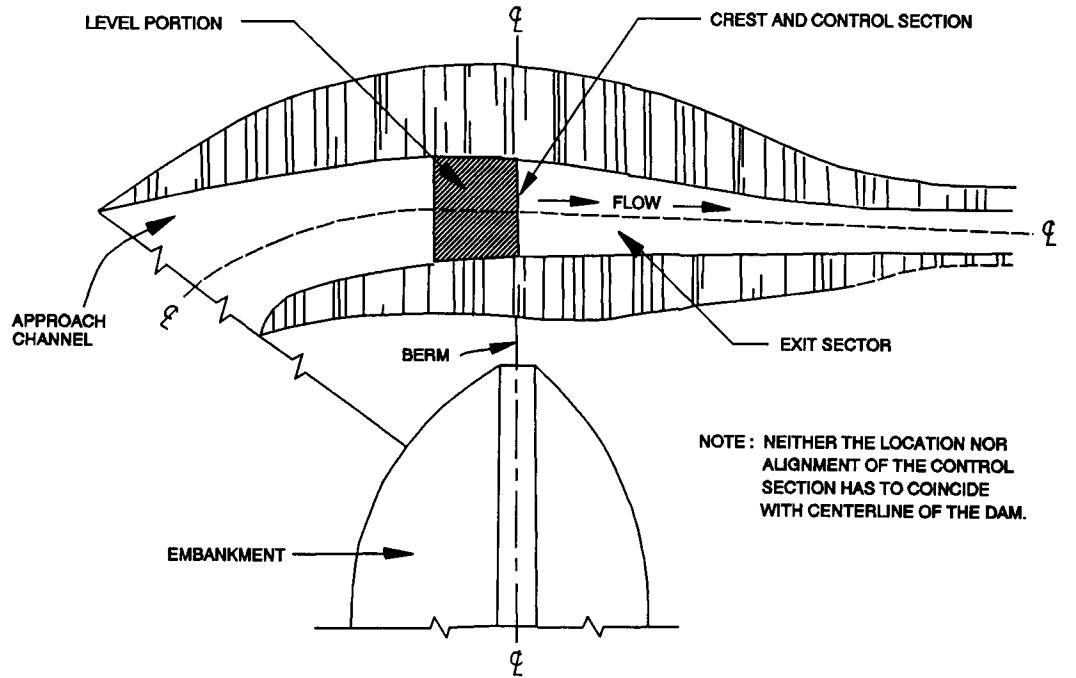
Typical Metric Conversions

cubic meters per second = cubic feet per second x 0.0283

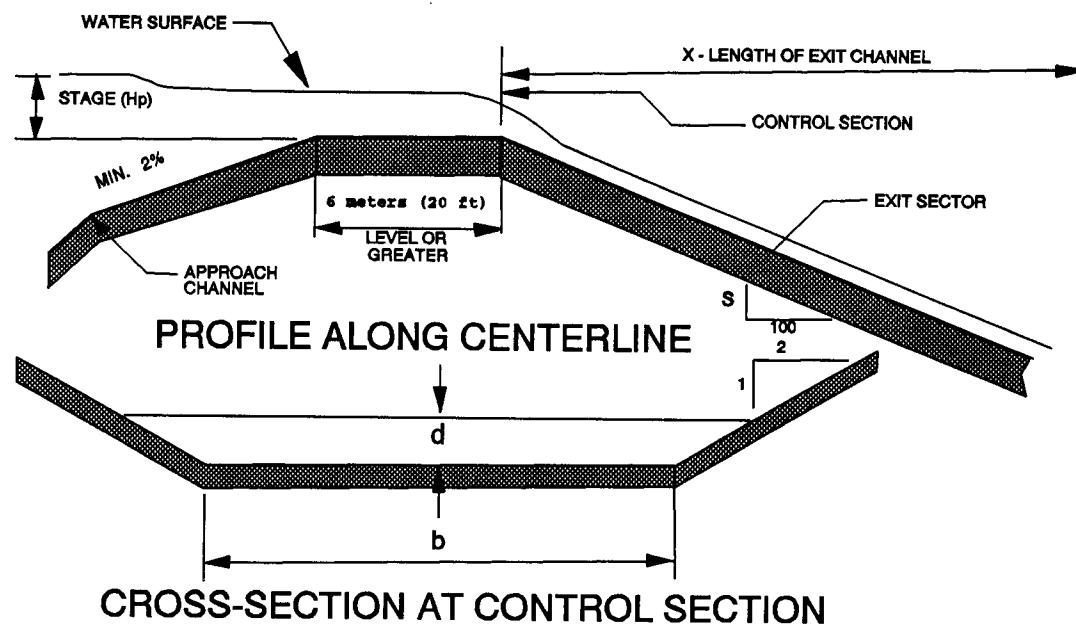
meters = feet x 0.3048

millimeters = inches x 25.4

FIGURE 14-4: EXCAVATED EARTH SPILLWAY



PLAN VIEW



slope from S does not increase discharge. If an exit slope (Se) steeper than S is used, then design procedures should be used to verify the adequacy of the exit channel.

3. Data to the right of heavy vertical lines should be used with caution, as the resulting sections will be either poorly proportioned or have excessive velocities.
- VIII. Re-estimate the elevation of the design high water and the top of the dam based upon the design of the principal spillway and the emergency spillway.

IX. Anti-Vortex Device and Trash Rack

- A. This design procedure for the anti-vortex device and trash rack refer only to riser pipes of corrugated metal. There are numerous ways to provide protection for concrete pipe; these include various hoods and grates and rebar configurations which should be a part of project-specific design and will frequently be a part of a permanent structure.
- B. Refer to Figure 14-5 and Table 14-4. Choose cylinder size, support bars, and top requirements from Table 14-4 based on the diameter of the riser pipe.

X. Anti-Seep Collars

- A. Anti-seep collars must be used under the conditions specified in the Design Criteria.
- B. Anti-seep collars are used to increase the seepage length along the barrel by 10%.
- C. Determine the length of the barrel within the saturated zone. This may be done by solving the following equation:

$$L_s = Y(Z + 4)(1 + (S/(0.25 - S)))$$

where:

- L_s = length of barrel in the saturated zone, meters (feet).
Y = the depth of water at the principal spillway crest, meters (feet).
Z = slope of the upstream face of embankment in Z meters (feet) horizontal to one vertical.
S = slope of the barrel in meters per meter (feet per feet).

FIGURE 14-5: ANTI-VORTEX DEVICE DESIGN

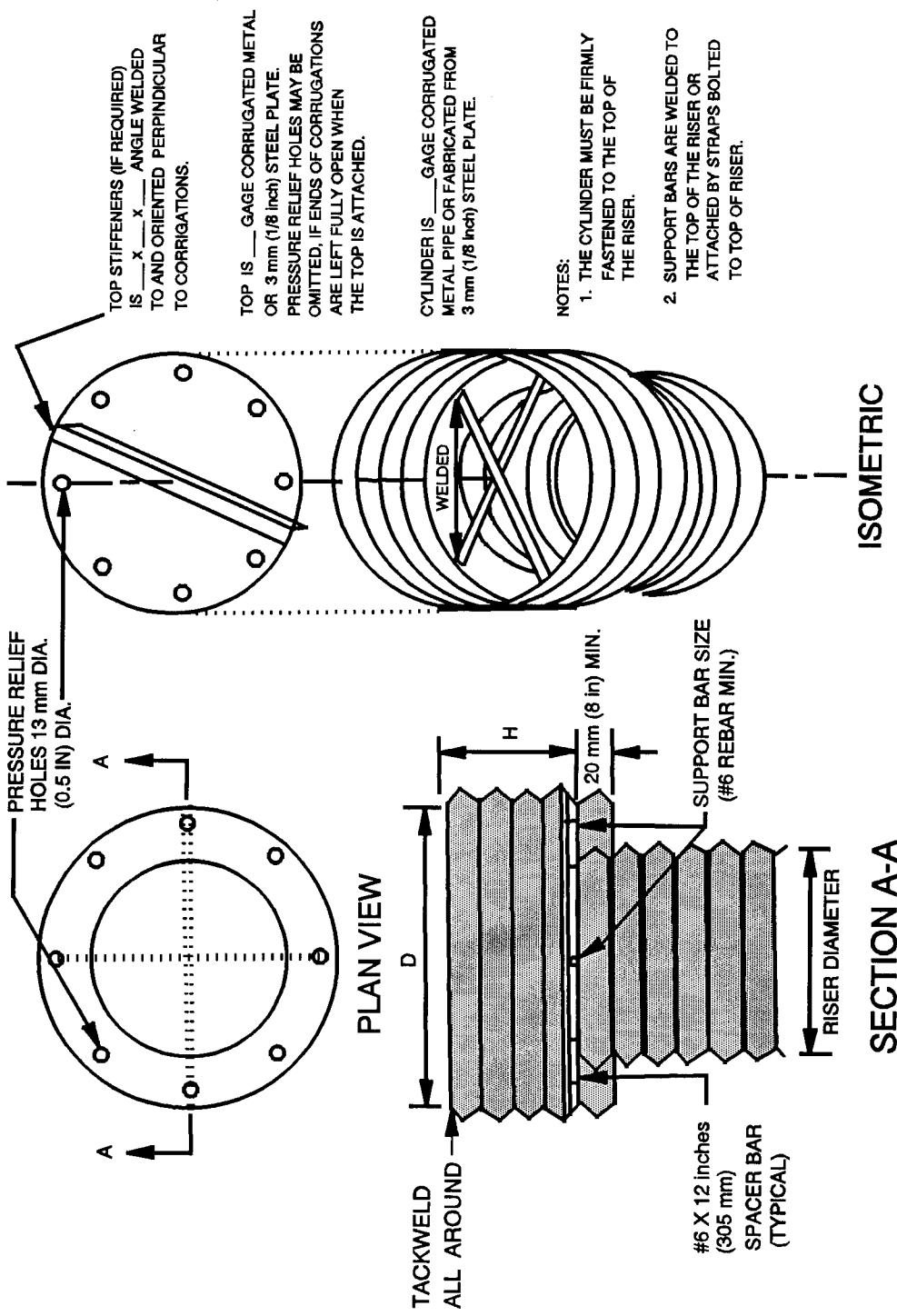


TABLE 14-4
CONCENTRIC TRASH RACK AND ANTI-VORTEX DESIGN TABLE

Riser Diameter, inches	Cylinder		Height, inches	Minimum Size Support Bar	Minimum Top	
	Diameter	Thickness, gage			Thickness	Stiffener
12	18	16	6	#6 Rebar or 1.5 x 1.5 x 3/16 angle	16 ga. (F&C)	-
15	21	16	7	" "	" "	-
18	27	16	8	" "	" "	-
21	30	16	11	" "	16 ga.(C), 14 ga. (F)	-
24	36	16	13	" "	" "	-
27	42	16	15	" "	" "	-
36	54	14	17	#8 Rebar	14 ga.(C), 12 ga. (F)	-
42	60	16	19	" "	" "	-
48	72	16	21	1.25" pipe or 1.25 x 1.25 x 0.25 angle	14 ga.(C), 10 ga. (F)	-
54	78	16	25	" "	" "	-
60	90	14	29	1.5" pipe or 1.5 x 1.5 x 0.25 angle	12 ga.(C), 8 ga. (F)	-
66	96	14	33	2" pipe or 2 x 2 x 3/16 angle	12 ga.(C), 8 ga. (F) w/stiffener	2 x 2 x 0.25 angle
72	102	14	36	" "	" "	2.5 x 2.5 x 0.25 angle
78	114	14	39	2.5" pipe or 2 x 2 x 0.25 angle	" "	" "
84	120	12	42	2.5" pipe or 2.5 x 2.5 x 0.25 angle	" "	2.5 x 2.5 x 5/16 angle

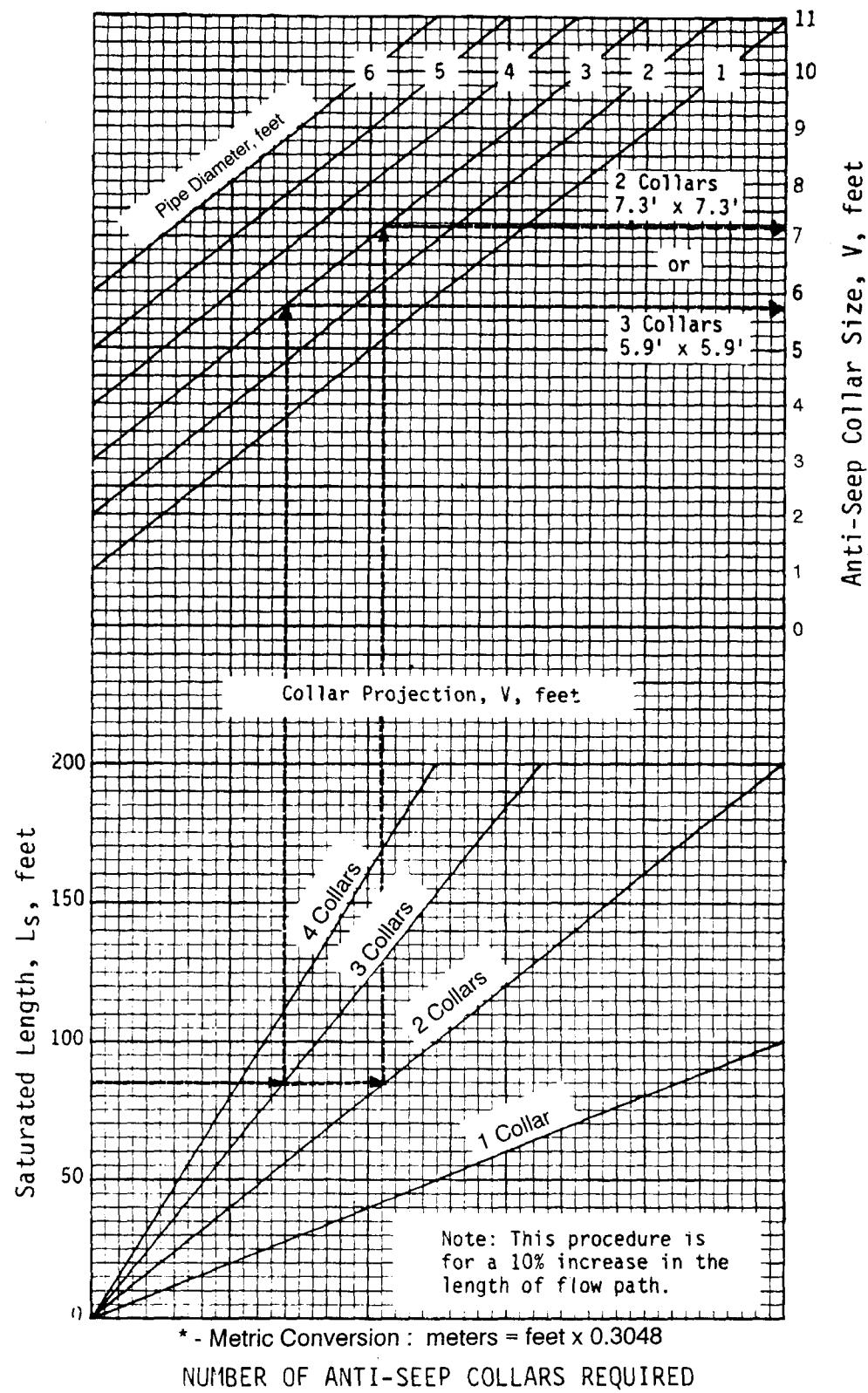
Note 1: The criterion for sizing the cylinder is that the area between the inside of the cylinder and the outside of the riser is equal to or greater than the area inside the riser. Therefore, the above table is invalid for use with concrete pipe risers.

Note 2: Corrugation for 12"-36" pipe measures 2 2/3" x 1/2"; for 42"-84" the corrugation measures 5" x 1" or 8" x 1".

Note 3: C = corrugated; F = flat.

Conversion Units: Millimeters = inches x 25.4

FIGURE 14-6: NUMBER OF ANTI-SEEP COLLARS REQUIRED



- D. Enter Table 14-6 with L_s . Move horizontally right until one of the lines is intersected. Move vertically until the correct line for barrel diameter is intersected. Move horizontally right to read P , the size of the anti-seep collar.
- E. If more than one collar is used, the spacing between collars should be 14 times the projection of the collar above the barrel.
- F. Collars should not be located closer than 600 millimeters (2 feet) to a pipe joint.

XI. Anchoring the Principal Spillway

- A. The principal spillway must be firmly anchored to prevent its floating.
- B. If the riser is over 3 meters (10 feet) high, the forces acting on the spillway must be calculated. A method of anchoring the spillway which provides a safety factor of 1.25 must be used (downward forces = 1.25 x upward forces).
- C. If the riser is 3 meters (10 feet) or less in height, choose one of the two methods in Figure 14-7 to anchor the principal spillway.

XII. Dewatering

- A. Refer to Figure 14-8 for details and orientation.
- B. Calculation of the diameter of the dewatering orifice:

Use a modified version of the discharge equation for a vertical orifice and a basic equation for the area of a circular orifice.

Naming the variables:

A	=	flow area of orifice, in square meters (square feet).
d	=	diameter of circular orifice, in millimeters (inches).
h	=	average driving head (maximum possible head measured from radius of orifice to crest of principal spillway <u>divided by 2</u>), in meters (feet)
Q	=	volumetric flowrate through orifice needed to achieve approximate 6-hour drawdown, cubic meters per second (cubic feet per second).

$$\begin{aligned} S &= \text{total storage available in dry storage area, cubic meters (cubic feet).} \\ Q &= S / 21,600 \text{ seconds} \end{aligned}$$

Use S for basin and find Q. Then substitute in calculated Q and find A:

$$A = \frac{Q}{(64.32 * \frac{h}{2})^{1/2} (0.6)}$$

Then, substitute in calculated A and find d:

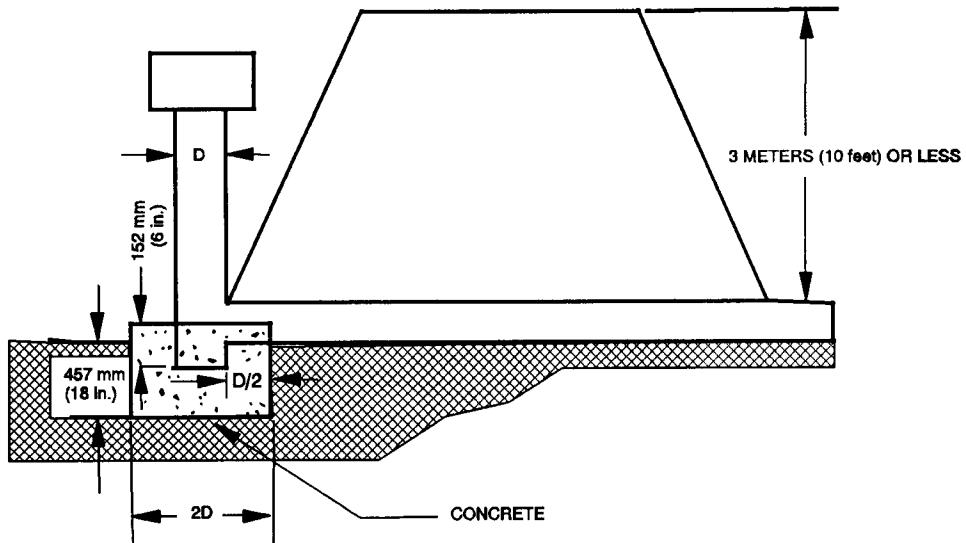
$$d^* = 2 * \left(\frac{A}{3.14} \right)^{1/2}$$

- * Diameter of dewatering orifice should never be less than 75 millimeters (3 inches) in order to help prevent clogging by soil or debris.

Note: Flexible tubing used should be at least 50 millimeters (2 inches) larger in diameter than the calculated orifice to promote improved flow characteristics.

**FIGURE 14-7: RISER PIPE BASE CONDITIONS
FOR EMBANKMENTS LESS THAN
3 METERS (10 FEET) HIGH**

CONCRETE BASE FOR EMBANKMENT 3 METERS (10 feet) OR LESS IN HEIGHT



STEEL BASE FOR EMBANKMENT 3 METERS (10 feet) OR LESS IN HEIGHT

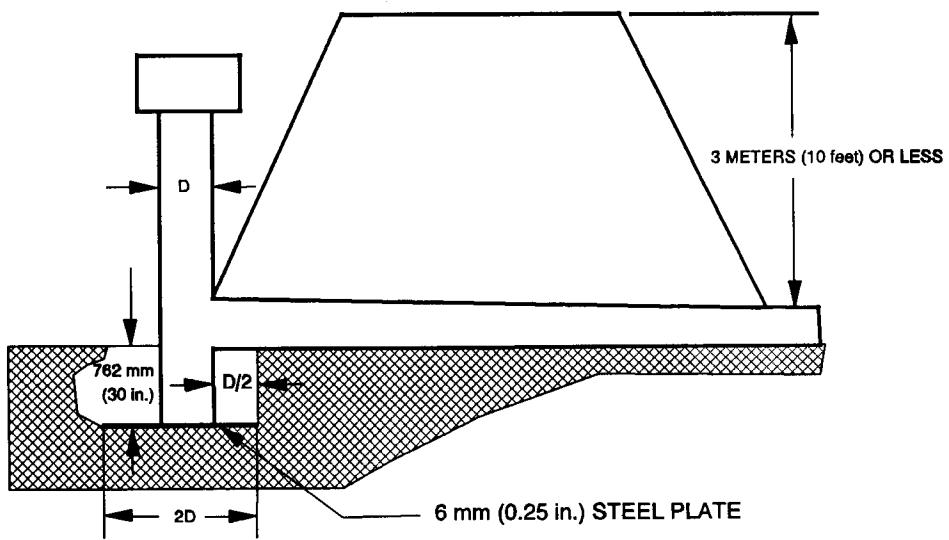
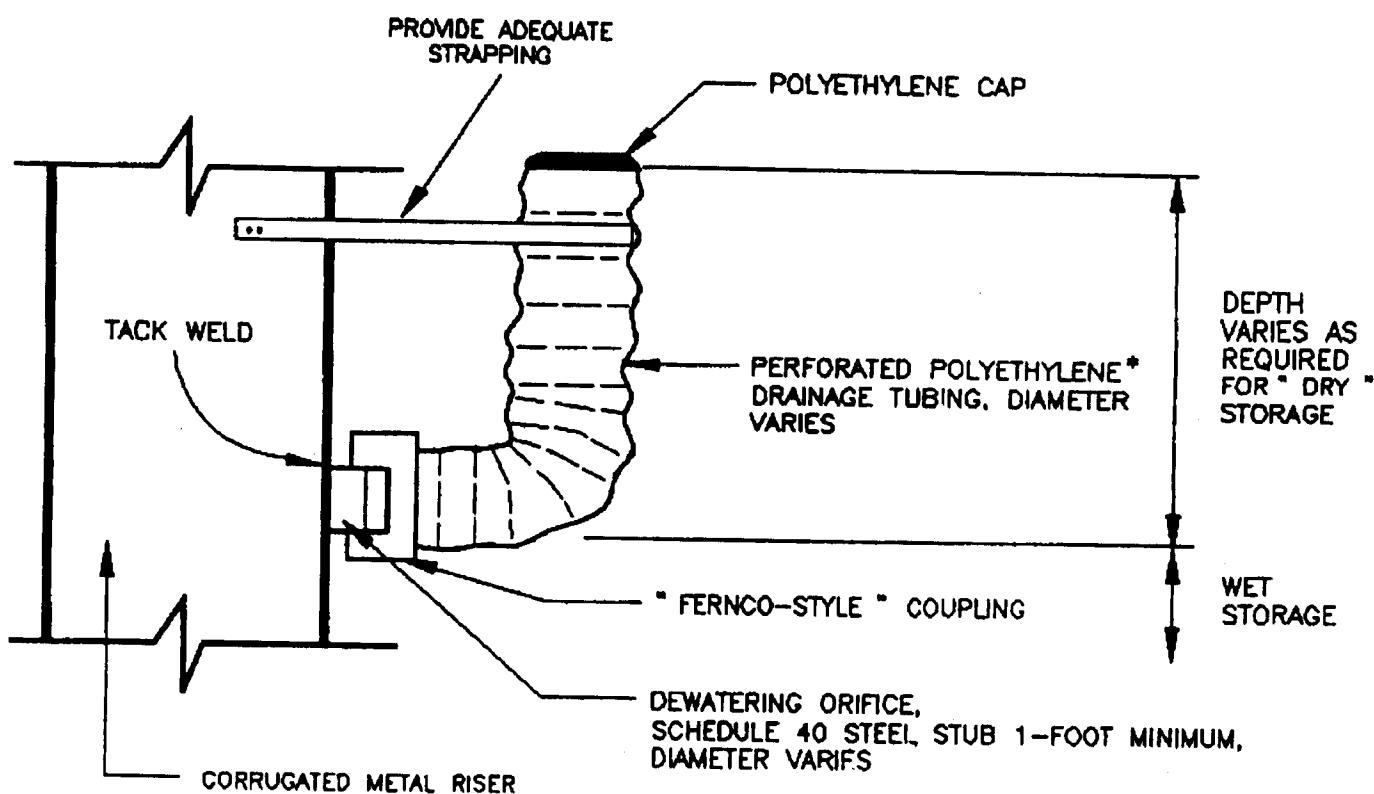


FIGURE 14-8: RECOMMENDED DEWATERING SYSTEM FOR SEDIMENT BASINS



NOTE: WITH CONCRETE RISER, USE PVC SCHEDULE 40 STUB FOR DEWATERING ORIFICE

*DRAINAGE TUBING SHALL COMPLY WITH ASTM F667
AND AASHTO M294

TEMPORARY SEDIMENT BASIN DESIGN DATA SHEET

(with or without an emergency spillway)

Project _____

Basin #_____ Location _____

Total area draining to basin: _____ hectares (acres).

Basin Volume Design

Wet Storage:

1. Minimum required volume = 127 cubic meters per hectare x Total Drainage Area (hectares).

$$127 \text{ m}^3/\text{hectare} \times \text{_____ hectares} = \text{_____ m}^3$$

$$(67 \text{ cubic yards per acre} \times \text{_____ acres}) = \text{_____ cubic yards}$$

2. Available basin volume = _____ m³ at elevation _____.
(From storage - elevation curve)

3. Excavate _____ m³ to obtain required volume*.

* Elevation corresponding to required volume = invert of the dewatering orifice.

4. Available volume before cleanout required.

$$63 \text{ m}^3 \text{ per hectare} \times \text{_____ hectares} = \text{_____ m}^3$$

$$(33 \text{ cubic yards per acre} \times \text{_____ acres}) = \text{_____ cubic yards}$$

5. Elevation corresponding to cleanout level = _____.
(From Storage - Elevation Curve)

6. Distance from invert of the dewatering orifice to cleanout level = _____.
Min. = 0.3 meters (1.0 ft.)

Dry Storage:

7. Minimum required volume = 127 cubic meters per hectare x Total Drainage Area (hectares).

127 m³/hectare x _____ hectares = _____ m³

(67 cubic yards per acre x _____ acres = _____ cubic yards)

8. Total available basin volume at crest of riser* = _____ m³ at elevation _____. (From Storage - Elevation Curve)

* Minimum = 254 cubic meters per hectare of total drainage area.

* Minimum = 134 cubic yards per acre of total drainage area.

9. Diameter of dewatering orifice = _____ millimeters (mm).

10. Diameter of flexible tubing = _____ mm (diameter of dewatering orifice plus 50 mm).

Preliminary Design Elevations

11. Crest of Riser = _____

Top of Dam = _____

Design High Water = _____

Upstream Toe of Dam = _____

Basin Shape

12. Length of Flow $\frac{L}{W_e}$ = _____

If > 2, baffles are not required _____

If < 2, baffles are required _____

Runoff

13. Q₂ = _____ cubic meters per second (cms)

14. Q₂₅ = _____ cms

Principal Spillway Design

15. With emergency spillway, required spillway capacity $Q_p = Q_2 = \underline{\hspace{2cm}}$ cms.
(riser and barrel)

Without emergency spillway, required spillway capacity $Q_p = Q_{25} = \underline{\hspace{2cm}}$ cms. (riser and barrel)

16. With emergency spillway:

Assumed available head (h) = $\underline{\hspace{2cm}}$ m. (Using Q_2)

$h = \text{Crest of Emergency Spillway Elevation} - \text{Crest of Riser Elevation}$

Without emergency spillway:

Assumed available head (h) = $\underline{\hspace{2cm}}$ m. (Using Q_{25})

$h = \text{Design High Water Elevation} - \text{Crest of Riser Elevation}$

17. Riser diameter (D_r) = $\underline{\hspace{2cm}}$ mm Actual head (h) = $\underline{\hspace{2cm}}$ m
(From Figure 14-3)

Note: Avoid orifice flow conditions.

18. Barrel length (l) = $\underline{\hspace{2cm}}$ m

Head (H) on barrel through embankment = $\underline{\hspace{2cm}}$ m
(From Table 14-1).

19. Barrel diameter = $\underline{\hspace{2cm}}$ mm
(From Table 14-2 [concrete pipe] or Table 14-1 [corrugated pipe]).

20. Trash rack and anti-vortex device

Diameter = $\underline{\hspace{2cm}}$ mm

Height = $\underline{\hspace{2cm}}$ mm

(From Table 14-4).

Emergency Spillway Design

21. Required spillway capacity $Q_e = Q_{25} - Q_p = \underline{\hspace{2cm}}$ cms.

22. Bottom width (b) = $\underline{\hspace{2cm}}$ m; the slope of the exit channel (s) = $\underline{\hspace{2cm}}$ m/meter;
and the minimum length of the exit channel (x) = $\underline{\hspace{2cm}}$ m (From Table 14-3).

Anti-Seep Collar Design

23. Depth of water at principal spillway crest (Y) = _____ m
Slope of upstream face of embankment (Z) = _____ : 1.
Slope of principal spillway barrel (S_b) = _____ %
Length of barrel in saturated zone (L_s) = _____ m
24. Number of collars required = _____ dimensions = _____
(from Figure 14-6).

Final Design Elevations

25. Top of Dam = _____
Design High Water = _____
Emergency Spillway Crest = _____
Principal Spillway Crest = _____
Dewatering Orifice Invert = _____
Cleanout Elevation = _____
Elevation of Upstream Toe of Dam
or Excavated Bottom of "Wet Storage
Area" (if excavation was performed) = _____